DOE/EP-0039

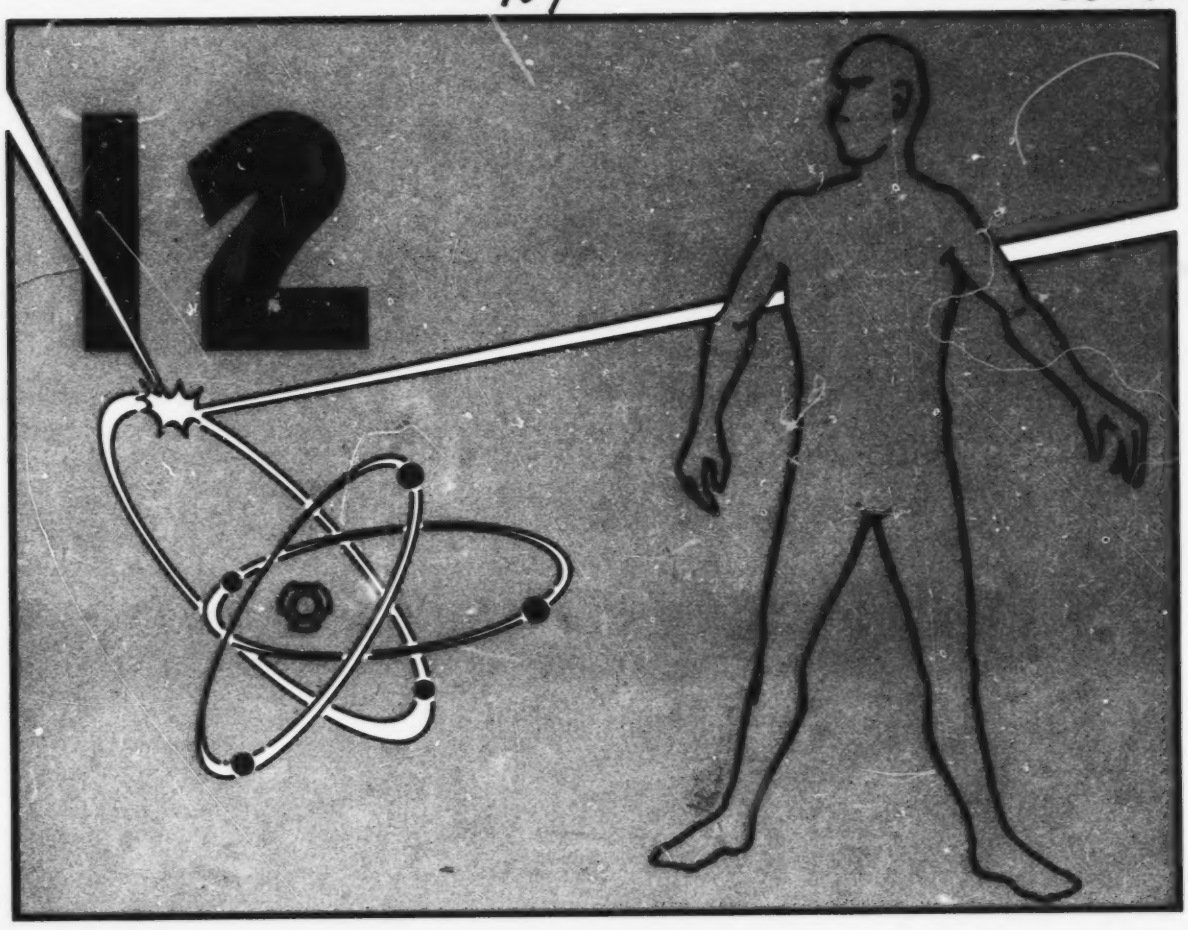
MAR 1 0 1982

COMPLETED

ORIGINAL

E1.42:979

(SERIAL)



Twelfth Annual Report Radiation Exposure For DOE and DOE Contractor Employees-1979

Published: February 1982

Prepared for:
U.S. Department of Energy
Assistant Secretary for Environmental
Protection, Safety, and Emergency Preparedness
Office of Nuclear Safety

Under Contract No. DE-AC06-76RL01830

BEST DOCUMENT AVAILABLE

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Printed Copy A04
Microfiche A01

Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts, (ERA); Government Reports Announcements* and Index (*GRA* and I); *Scientific and Technical Abstract Reports (STAR);* and publication, NTIS-PR-360 available from (NTIS) at the above address.

BEST DOCUMENT AVAILABLE

DOE/EP-0039
UC-41

Twelfth Annual Report Radiation Exposure For DOE and DOE Contractor Employees-1979

Prepared by:
Pacific Northwest Laboratory
Richland, Washington 99352

Under Contract No. DE-AC06-76RL01830

Prepared for:

U.S. Department of Energy
Assistant Secretary for Environmental
Protection, Safety, and Emergency Preparedness
Office of Nuclear Safety
Washington, DC 20545

BLANK PAGE

TWELFTH ANNUAL REPORT
RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES
1979

PREFACE

This report is one of a series of annual reports provided by the U.S. Department of Energy (DOE) summarizing occupational radiation exposures received by DOE and DOE contractor employees. These reports provide an overview of radiation exposures received each year as well as identification of trends in exposures being experienced over the years.

In 1968, the U.S. Atomic Energy Commission (AEC) established a program for reporting certain occupational radiation exposure information to a central radiation records repository. At the same time, a contract was made with Union Carbide Corporation at Oak Ridge, Tennessee, to computerize the processing of the radiation exposure reporting system. Annual summary reports were published from 1969 through 1973 (WASH-1350-R1 through WASH-1350-R6), and included information on AEC contractor employees and visitors, as well as employees and visitors of companies in the private sector licensed by the AEC.

In January 1975, with the separation of the AEC into the Energy Research and Development Agency (ERDA) and the U.S. Nuclear Regulatory Commission (NRC), each agency assumed responsibility for collecting and maintaining occupational exposure information reported by the facilities under its jurisdiction. Former AEC licensees reported to the NRC while contractors reported to ERDA. At the same time, a contract was made with Union Carbide Corporation at Oak Ridge, Tennessee, to computerize the reporting and processing of both the ERDA and NRC radiation exposure reporting systems. On October 1, 1977, DOE was formed and assumed the responsibilities of ERDA. Processing and programming of exposure information continued at Oak Ridge until October 1978, when the management and further development of the DOE radiation exposure reporting system was assigned to the System Safety Development Center, EG&G Idaho, Inc.; the NRC system remained at Oak Ridge.

Radiation exposure data for ERDA and ERDA contractor employees and visitors for 1974 through 1976 were reported in ERDA 76/119, ERDA 77-29, and DOE/EV-0011/9. The DOE and DOE contractor radiation exposure data for 1977, 1978, and 1979 were presented in DOE/EVO-0066/10, 11, and 12 respectively. This report is a revision of the 1979 document.

Previous reports for AEC/ERDA/DOE, government and contractor employees and visitors may be obtained from the U.S. DOE Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

BEST DOCUMENT AVAILABLE

BLANK PAGE

SUMMARY

All Department of Energy (DOE) and DOE contractors are required by DOE Order 5484.1, Chapter IV to submit occupational exposure records to a central repository. The data required include a summary of whole-body exposure to ionizing radiation, a summary of internal depositions of radioactive materials above specified limits, and occupational exposure reports for terminating employees. This report is a summary of the data submitted by DOE and DOE contractors for 1979 and is a revision of the previously published report.

A total of 104,986 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposure in 1979. This represents 81% of all DOE and DOE contractor employees and is a 3% increase over the number of individuals monitored in 1978. In addition to the employees, 89,585 visitors were also monitored.

Of all employees monitored, 47.6% received a dose equivalent that was less than measurable, 50.8% a measurable exposure less than 1 rem, and 1.6% an exposure greater than 1 rem. The exposure received by 89.1% of the visitors to DOE facilities was less than measurable. Only 10.8% of the visitors received a measurable exposure less than 1 rem, and 0.1% of the visitors received an exposure greater than 1 rem. Three DOE contractor employees at three separate facilities received whole-body dose equivalents greater than 5 rem during 1979.

The collective dose equivalent for the DOE and DOE contractor employees was 9,043 person-rem. The collective dose equivalent for visitors was 622 person-rem. The total dose equivalent for employees and visitors combined was 9,665 person-rem. The average dose equivalent for all individuals (employees and visitors) monitored was 50 mrem and the average dose equivalent for all individuals who received a measurable exposure was 150 mrem. The highest average dose equivalent was observed for employees monitored at fuel processing facilities (324 mrem) and the lowest among visitors (7 mrem) to DOE facilities. These averages are significantly less than the DOE 5-rem/year radiation protection standard for whole-body exposures.

Two reported cases of internal depositions were reported in 1979. In both cases, the depositions were less than the annual dose-equivalent standard. Internal depositions were the result of accidental, not planned, exposures.

A total of 9,868 monitored employees terminated their employment in 1979. The average cumulative dose equivalent for terminated employees who worked one to two years was 0.29 rem; three to four years, 0.40 rem; five to six years, 0.68 rem; and longer than six years, 2.39 rem. The average cumulative dose equivalent for employees who terminated with more than six years of employment appears high in comparison with the other data. However, this average includes the cumulative exposure of individuals who worked for DOE or DOE contractors for over 20 years.

BLANK PAGE

CONTENTS

PREFACE iii

SUMMARY v

INTRODUCTION 1

SUMMARY OF WHOLE-BODY IONIZING RADIATION EXPOSURES 2

DISTRIBUTION BY DOSE INTERVAL 3
DISTRIBUTION BY FACILITY TYPE 9
DISTRIBUTION BY FIELD ORGANIZATION 11

SUMMARY OF INTERNAL EXPOSURES 14

SUMMARY OF WORKER TERMINATIONS 15

APPENDIX A—DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE FOR EACH DOE FIELD ORGANIZATION, 1979 ..... A.1

APPENDIX B—DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR FOR EACH DOE FIELD ORGANIZATION, 1979 ..... B.1

APPENDIX C—DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION, 1979 ..... C.1

BEST DOCUMENT AVAILABLE

FIGURES

1 Comparison of Number of Employees, Number of Employees Monitored, and Number of Employees Monitored Who Received No Measurable Dose Equivalent 4

2 Percent of Monitored Employees and Percent of Monitored Visitors Who Received an Exposure Less Than Measurable, Less Than 1 rem, or Greater Than 1 rem 5

3 Contribution of Each Dose Equivalent Interval to the Total Collective Dose Equivalent, 1979 6

4 Total Collective Dose Equivalent for all DOE/DOE Contractor Employees Who Received an Exposure Greater Than 1 rem 8

5 Contribution of Each Facility Type to the Total Collective Dose Equivalent 9

TABLES

1 Radiation Protection Standards for External and Internal Dose Equivalents for Individuals in Controlled Areas 1

2 Distribution of Whole Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees and Visitors by Dose-Equivalent Interval 3

3 Distribution of Whole Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees, 1965-1979 7

4 Distribution of Annual Whole Body Exposures for DOE/DOE Contractor Employees and Visitors by Facility Type, 1979 10

5 Collective Dose Equivalent by Facility Type for DOE/DOE Contractor Employees and Visitors, 1979 11

6 Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1979 12

7 Fraction of Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors Attributed to a Facility Type Within Each Field Organization, 1979 13

8 Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1974-1979 14

9 Dose Distributions for Cases of Internal Body Depositions, 1977-1979 15

10 Average Cumulative Dose Equivalent for Individuals Terminating in 1979 15

BEST DOCUMENT AVAILABLE

A.1 Distribution of Annual Whole-Body Exposures by Facility Type—
Albuquerque Field Organization, 1979 ..... A.1

A.2 Distribution of Annual Whole-Body Exposures by Facility Type—
Chicago Field Organization, 1979 ..... A.2

A.3 Distribution of Annual Whole-Body Exposures by Facility Type—
Grand Junction Field Organization, 1979 ..... A.3

A.4 Distribution of Annual Whole-Body Exposures by Facility Type—
Idaho Field Organization, 1979 ..... A.4

A.5 Distribution of Annual Whole-Body Exposures by Facility Type—
Nevada Field Organization, 1979 ..... A.5

A.6 Distribution of Annual Whole-Body Exposures by Facility Type—
Oak Ridge Field Organization, 1979 ..... A.6

A.7 Distribution of Annual Whole-Body Exposures by Facility Type—
Pittsburgh Naval Reactor Field Organization, 1979 ..... A.7

A.8 Distribution of Annual Whole-Body Exposures by Facility Type—
Richland Field Organization, 1979 ..... A.8

A.9 Distribution of Annual Whole-Body Exposures by Facility Type—
San Francisco Field Organization, 1979 ..... A.9

A.10 Distribution of Annual Whole-Body Exposures by Facility Type—
Savannah River Field Organization, 1979 ..... A.10

A.11 Distribution of Annual Whole-Body Exposures by Facility Type—
Schenectady Naval Reactor Field Organization, 1979 ..... A.11

B.1 Distribution of Annual Whole-Body Exposures by Contractor—
Albuquerque Field Organization, 1979 ..... B.1

B.2 Distribution of Annual Whole-Body Exposures by Contractor—
Chicago Field Organization, 1979 ..... B.4

B.3 Distribution of Annual Whole-Body Exposures by Contractor—
Grand Junction Field Organization, 1979 ..... B.6

B.4 Distribution of Annual Whole-Body Exposures by Contractor—
Idaho Field Organization, 1979 ..... B.7

B.5 Distribution of Annual Whole-Body Exposures by Contractor—
Nevada Field Organization, 1979 ..... B.10

B.6 Distribution of Annual Whole-Body Exposures by Contractor—
Oak Ridge Field Organization, 1979 ..... B.13

BEST DOCUMENT AVAILABLE

B.7 Distribution of Annual Whole-Body Exposures by Contractor—
Pittsburgh Naval Reactor Field Organization, 1979 ..... B.16

B.8 Distribution of Annual Whole-Body Exposures by Contractor—
Richland Field Organization, 1979 ..... B.17

B.9 Distribution of Annual Whole-Body Exposures by Contractor—
San Francisco Field Organization, 1979 ..... B.19

B.10 Distribution of Annual Whole-Body Exposures by Contractor—
Savannah River Field Organization, 1979..... B.21

B.11 Distribution of Annual Whole-Body Exposures by Contractor—
Schenectady Naval Reactor Field Organization, 1979..... B.22

C.1 Distribution of Annual Whole-Body Exposures for DOE Government
Employees and Visitors by DOE Field Organization, 1979 ..... C.1

BEST DOCUMENT AVAILABLE

TWELFTH ANNUAL REPORT
RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES
1979

INTRODUCTION

One of the basic Department of Energy (DOE) radiation protection policy objectives is that radiation exposures be maintained as low as is reasonably achievable (ALARA) and within the occupational exposure guidelines provided in DOE Order 5480.1, Chapter XI (Table 1). Assurance that occupational exposures do not exceed the guidelines is not considered, in itself, sufficient. All operations are to be conducted "in a manner to assure that radiation exposures to individuals and population groups are limited to the lowest levels technically and economically feasible."

TABLE 1. Radiation Protection Standards for External and Internal Dose Equivalents for Individuals in Controlled Areas

Type of Exposure	Exposure Period	Dose Equivalent (Dose or Dose Commitment)(rem)[a]
Whole body, head and trunk, gonads, lens of the eye,[b] red bone marrow, active blood forming organs.	Year	5[c]
	Calendar quarter	3
Unlimited areas of the skin (except hands and forearms), other organs, tissues, and organ systems (except bone).	Year	15
	Calendar quarter	5
Bone	Year	30
	Calendar quarter	10
Forearms[d]	Year	30
	Calendar quarter	10
Hands[d] and feet	Year	75
	Calendar quarter	25

[a] To meet the dose commitment standards above, operations must be conducted in such a manner that it would be unlikely that an individual would assimilate in a critical organ, by inhalation, ingestion, or absorption, a quantity of radionuclide(s) that would commit the individual to an organ dose which exceeds the limits specified in this table.

[b] A beta exposure below a maximum energy of 700 keV will not penetrate the lens of the eye; therefore, the applicable limit for these energies would be that for the skin (15 rem/year).

[c] In special cases with the approval of the Director, Division of Operational and Environmental Safety, a worker may exceed 5 rem/year provided his/her average exposure per year since age 18 will not exceed 5 rem/year.

[d] All reasonable effort shall be made to keep exposure of forearms and hands to the general limit for the skin.

BEST DOCUMENT AVAILABLE

To assist in the determination that exposures to individuals are maintained at the lowest level practicable, DOE requires the submittal of occupational radiation exposure records to a central repository. The data required includes a summary of whole-body exposure to ionizing radiation, a summary of internal depositions of radioactive materials, and occupational exposure reports for terminating employees. The central data base also includes occupational radiation exposure information for the Atomic Energy Commission (AEC) and the Energy Research and Development Agency (ERDA).

The DOE Office of Operational Safety initiated a study during FY-80 to review the status of the Radiation Records Repository. As part of that study , this revision of the Twelfth Annual Report of Radiation Exposures for DOE and DOE Contractor Employees was prepared. This report is a summary of the data submitted in 1979 by DOE and DOE contractor offices. For the purpose of trend analysis, the data is compared to that reported in previous years. The data used to prepare this report is presented in Appendix A, "Distribution of Whole Body Exposures by Facility Type for Each DOE Field Organization, 1979"; Appendix B, "Distribution of Annual Whole Body Exposures by Contractor for Each DOE Field Organization, 1979"; and Appendix C, "Distribution of Annual Whole Body Exposures for DOE Government Employees and Visitors by DOE Field Organization, 1979."

SUMMARY OF WHOLE-BODY IONIZING RADIATION EXPOSURES

Monitoring is required by DOE Order 5480.1, Chapter XI, where the potential exists for an individual to receive a dose or dose commitment in any calendar quarter in excess of the 10% of the quarterly or annual occupational exposure guidelines shown in Table 1. Depending on the administrative policy of the contractor, monitoring may also be provided to individuals, such as clerical workers, for whom the exposure potential is extremely low.

The number of individuals who received an occupational whole-body exposure in one of 18 dose-equivalent intervals ranging from "less than measurable" to "greater than 10 rem" is provided annually by each DOE contractor and DOE office. A positive, measurable exposure is any recorded exposure greater than the minimum sensitivity of a personnel monitoring device. The data is further subdivided into one of 10 facility types.

Contractors have the option of reporting the distribution of whole body-occupational dose equivalents only for those individuals for whom monitoring is required, or for all those for whom monitoring is provided. Many contractors choose to report the latter, thus increasing the number of individuals who are considered to be radiation workers. To account for this effect, the average dose equivalent per individual receiving a measurable exposure is calculated as well as the average dose equivalent per individual monitored.

The annual collective dose equivalent is calculated by multiplying the number of individuals in each dose range by the midpoint of the range, and then summing the products. This procedure allows an estimate of the collective dose equivalent to be calculated without knowledge of each individual's annual dose. However, a source of error is introduced to the calculation by the assumption that the midpoint of the dose-equivalent range is the mean dose equivalent of the individuals reported in each dose-equivalent range. Frequently, the actual mean dose equivalent in each range is less than the assumed arithmetic mean. Thus, collective dose equivalents presented in this report may be slightly higher than the actual collective dose equivalents.

DISTRIBUTION BY DOSE INTERVAL

The number of employees and visitors who received a dose equivalent in each of 18 dose-equivalent intervals is presented in Table 2. A total of 104,986 DOE and DOE contractor employees were monitored for whole body ionizing radiation exposure in 1979. This represents 81% of all DOE and DOE contractor employees. In addition to the employees, 89,585 visitors were also monitored. Visitors may include radiation workers employed by a DOE contractor present on an interim basis at another DOE facility.

TABLE 2. Distribution of Whole Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees and Visitors by Dose-Equivalent Interval

Dose Equivalent Interval	Number of Persons			Collective Person-rem		
(rem)	Employees	Visitors	Total	Employees	Visitors	Total
<Measurable	50,003	79,841	129,844	0	0	0
Measurable to 0.10	42,266	9,333	51,599	2,113	467	2,580
0.10 to 0.25	5,630	243	5,873	985	43	1,028
0.25 to 0.50	3,011	83	3,094	1,129	31	1,160
0.50 to 0.75	1,512	46	1,558	946	28	974
0.75 to 1.00	816	13	829	714	11	725
1 to 2	1,286	23	1,309	1,929	34	1,963
2 to 3	416	3	419	1,040	8	1,048
3 to 4	33	0	33	115	0	115
4 to 5	10	0	10	45	0	45
5 to 6	1	0	1	5	0	5
6 to 7	0	0	0	0	0	0
7 to 8	0	0	0	0	0	0
8 to 9	0	0	0	0	0	0
9 to 10	1	0	1	9	0	9
>10	1	0	1	13	0	13
TOTAL	104,986	89,585	194,571	9,043	622	9,665

A comparison of the number of DOE and DOE contractor employees, the number of employees monitored and the number of employees monitored who did not receive a measurable dose equivalent for the past five years is presented in Figure 1. A gradual increase in the total number of employees can be observed. However, the number of employees monitored who did not receive a measurable dose equivalent has remained relatively constant until 1979, when this number increased slightly.

Of all employees monitored in 1979, 47.6% received a dose equivalent that was less than measurable, 50.8% a measurable exposure less than 1 rem, and 1.6% an exposure greater than 1 rem (Figure 2). The exposure received by 89.1% of the visitors to DOE facilities was less than measurable. Only 10.8% of the visitors received an exposure between measurable and 1 rem, and 0.1% of the visitors received an exposure greater than 1 rem (Figure 2). Three DOE contractor employees at three separate facilities received whole-body dose equivalents greater than 5 rem during 1979.

BEST DOCUMENT AVAILABLE

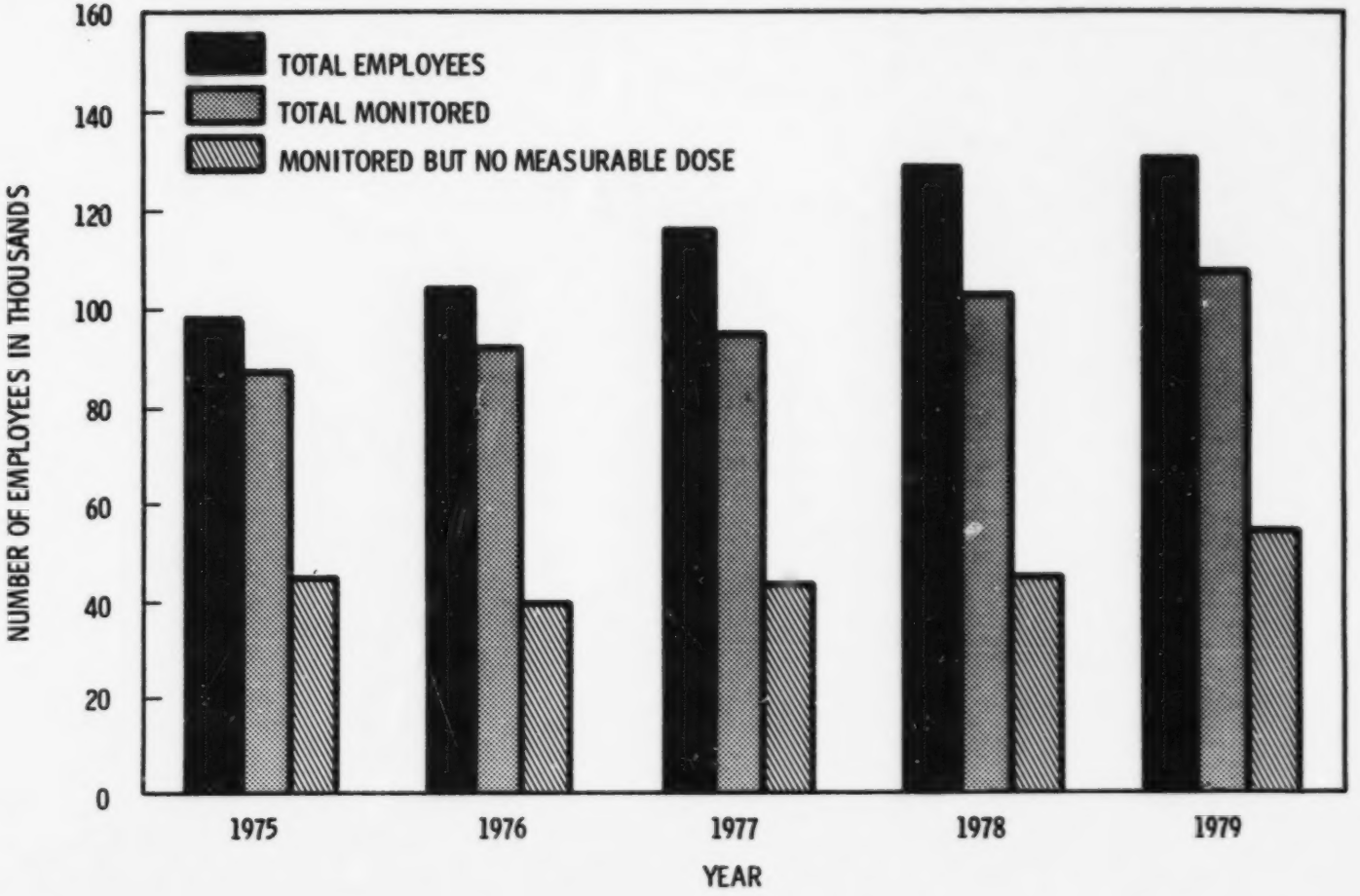


FIGURE 1. Comparison of Number of Employees, Number of Employees Monitored, and Number of Employees Monitored Who Received No Measurable Dose Equivalent

BEST DOCUMENT AVAILABLE

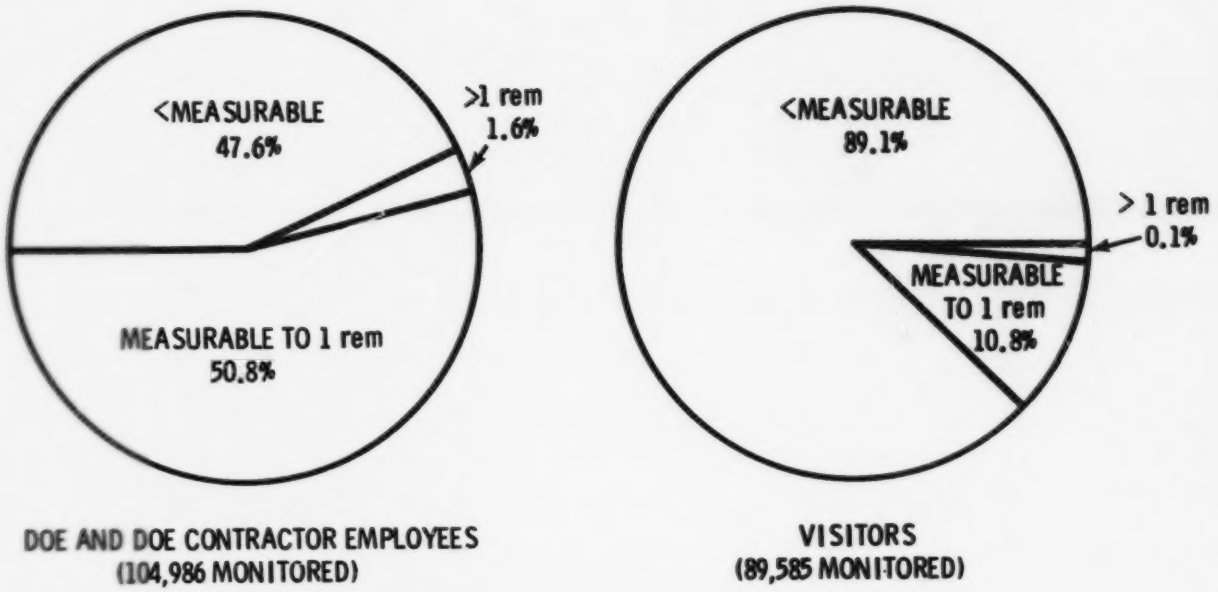


FIGURE 2. Percent of Monitored Employees and Percent of Monitored Visitors Who Received an Exposure Less than Measurable, Less Than 1 rem, or Greater Than 1 rem

The collective dose equivalent was 9,403 person-rem for all DOE and DOE contractor employees, and 622 person-rem for visitors to DOE facilities, for a total collective dose equivalent of 9,665 person-rem. The contribution of the individuals in each dose-equivalent interval to the collective dose equivalent is shown in Figure 3. Individuals whose exposure was less than 1 rem contributed the greatest portion of the total person-rem.

The distribution of whole-body exposures for the years 1965-1979 is presented in Table 3. As can be observed in Table 3, the number of employees who received a dose equivalent greater than 1 rem has gradually declined since 1965. This same downward trend is shown in Figure 4, which shows the collective dose equivalent for all individuals from 1965-1979 who received an exposure greater than 1 rem. The collective dose equivalent for individuals who received an exposure less than 1 rem was not included because prior to 1974, a less-than-measurable exposure was not distinguished from measurable exposures in the reporting system. This decrease in the collective dose equivalent has been achieved even though some work was performed in older facilities which were not constructed using current design criteria. These trends reflect both changes in the nature of the work performed at DOE facilities and the consistent application of ALARA practices throughout all DOE operations.

BEST DOCUMENT AVAILABLE

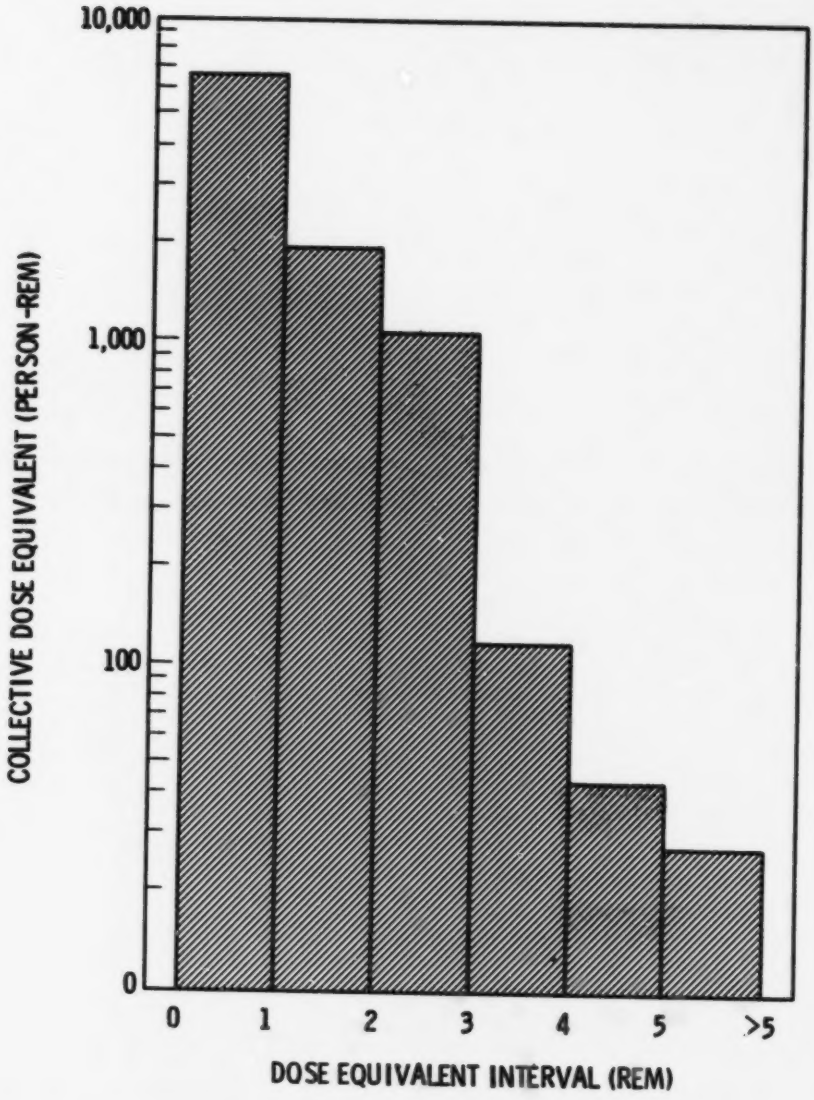


FIGURE 3. Contribution of Each Dose-Equivalent Interval to the Total Collective Dose Equivalent, 1979

BEST DOCUMENT AVAILABLE

TABLE 3. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees, 1965-1979

Year	Dose Equivalent Ranges (rem) 0-1[a] <Meas.	Meas.-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	>12	Total Monitored
1965	128,360		4,158	1,704	515	294	70	32	26	25	22	6	2		135,214
1966	131,522		3,706	1,630	593	313	88	47	24	6	2			1	137,932
1967	102,510		3,472	1,572	555	168	35	29	23	17	4	1			108,386
1968	103,206		2,799	1,408	425	144	3	1							107,986
1969	98,625		2,554	1,313	335	86	4					1			102,918
1970	92,185		2,698	1,329	279	158	5	4	2		1				96,661
1971	90,640		2,380	888	275	118	8	3				1		2	94,315
1972	86,077		2,130	929	219	95	8	2							89,460
1973	89,071		1,944	727	172	60	2	1							91,977
1974	43,184	32,500	1,667	688	149	40	4								78,232
1975	43,310	42,141	1,846	753	232	142				1					88,425
1976	40,083	47,886	1,679	475	70	6	1								90,200
1977	43,017	49,948	1,579	545	103	23			1	2				2	95,220
1978	44,898	55,296	1,323	439	53	11									102,020
1979	50,003	53,235	1,286	416	33	10	1				0			0	104,986

[a]Separation of data prior to 1974 is unavailable.

BEST DOCUMENT AVAILABLE

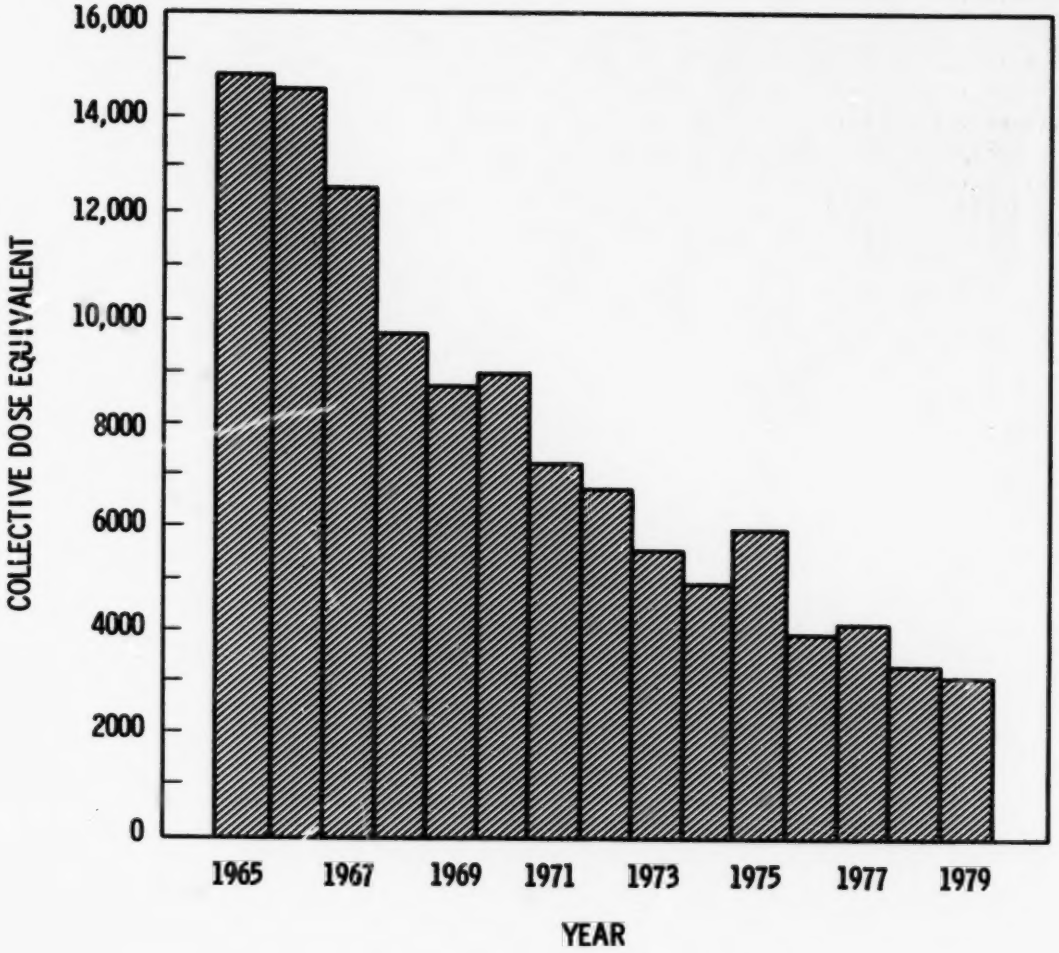


FIGURE 4. Total Collective Dose Equivalent for All DOE/DOE Contractor Employees Who Received an Exposure Greater Than 1 rem

BEST DOCUMENT AVAILABLE

DISTRIBUTION BY FACILITY TYPE

The number of individuals and the distribution of the annual whole-body exposures in each of 11 facility categories was reported to the central repository. For the purpose of this report, visitors were considered a facility type. The contribution of each facility type to the collective dose equivalent is shown in Figure 5. The largest percentage of the total collective dose equivalent was in the category "Other." Examples of facilities included in the "Other" category include construction and radioactive waste handling. "General Research" was a close second. As would be expected, the smallest contribution was from DOE offices. A summary of the data submitted is presented in Table 4.

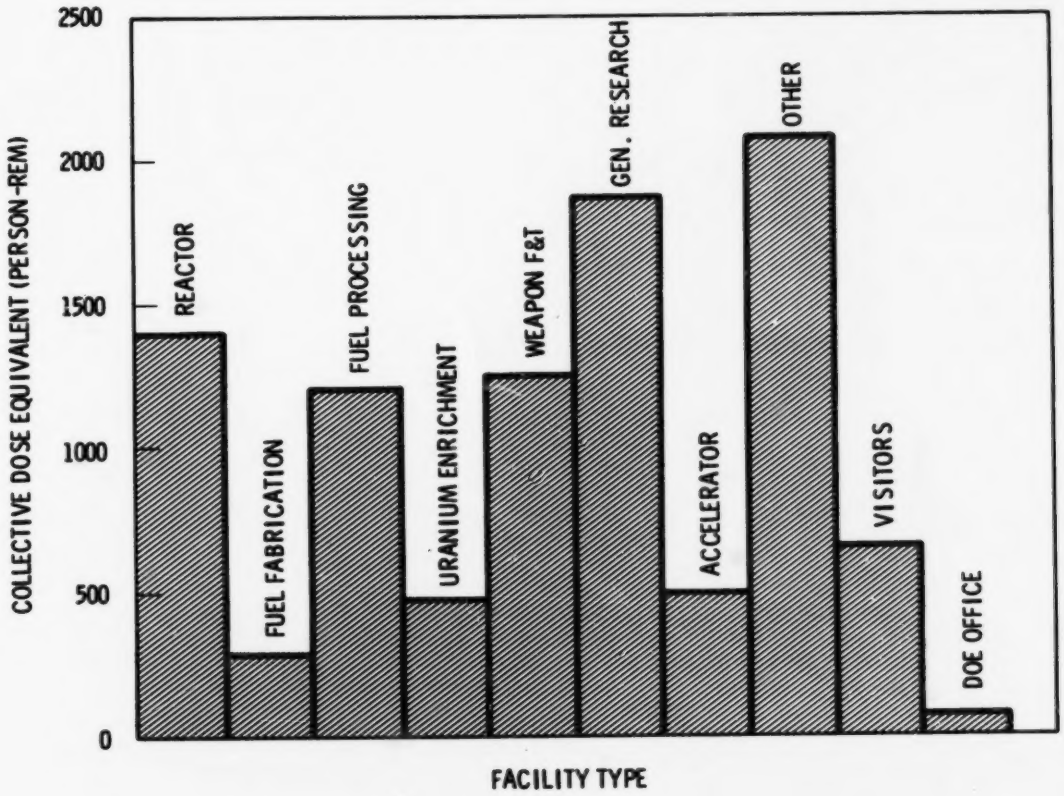


FIGURE 5. Contribution of Each Facility Type to the Total Collective Dose Equivalent

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 4. Distribution of Annual Whole-Body Exposures for DOE/DOE Contractor Employees and Visitors by Facility Type, 1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	6,995	2,627	2,415	734	534	239	100	174	160	12								1,389
Fuel Fabrication	1,095	147	502	152	118	76	40	50	10									278
Fuel Processing	3,730	1,119	1,021	460	380	236	138	276	97	3								1,209
Uran. Enrichment	11,144	2,464	8,474	184	18	2	2											466
Weapon F&T	18,409	7,582	9,249	781	379	152	83	144	29	1	7	1				1		1,247
Gen. Research	41,711	28,157	10,438	1,658	715	340	171	198	25	6	2						1	1,845
Accelerator	3,402	1,787	878	299	182	76	52	95	24	8	1							492
Other	16,180	4,460	8,674	1,329	677	389	229	348	71	3								2,074
Visitors	89,585	79,841	9,333	243	83	46	13	23	3									622
DOE Offices	2,320	1,660	615	33	8	2	1	1										43
TOTAL EXPOSURES	194,571	129,844	51,599	5,873	3,094	1,558	829	1,309	419	33	10	1				1	1	9,665
TOTAL PERSON-REM			2,580	1,028	1,160	974	725	1,963	1,048	115	45	5				9	13	9,665

The average dose equivalent by facility type, per individual monitored, and per individual monitored with measurable exposure, is shown in Table 5. The average dose equivalent per individual monitored for all facilities combined was 50 mrem. The highest average dose equivalent per individual monitored was observed at fuel processing facilities (324 mrem) and the lowest was observed for visitors to DOE facilities (7 mrem).

TABLE 5. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Facility Type, 1979

Facility Type	No. Individuals Monitored	No. Individuals With Measurable Exposure	Total No. Person-rem	Average Dose Equivalent (mrem) Per Individual Monitored	Average Dose Equivalent (mrem) Per Individual Monitored With Measurable Exposures
Reactor	6,995	4,368	1,389	199	318
Fuel Fab.	1,095	948	278	253	293
Fuel Proc.	3,730	2,611	1,209	324	463
Uran. Enrich.	11,144	8,680	466	42	54
Weapon F&T	18,409	10,827	1,247	68	115
Gen. Research	41,711	13,554	1,845	44	136
Accelerator	3,402	1,615	492	145	305
Other	16,180	11,720	2,074	128	177
Visitors	89,585	9,744	622	7	64
DOE Offices	2,320	660	43	18	65
TOTAL	194,571	64,727	9,665	50	149

DISTRIBUTION BY FIELD ORGANIZATION

For each field organization the number of employees monitored and the collective dose equivalent are shown in Table 6. Differences in the collective dose equivalent at each field organization reflect differences in the nature of the work performed and the administrative policy concerning whether the dose distribution is reported for all employees or only those for whom monitoring is required. Table 7 provides an indication of the work done at each field organization by showing the fraction of the collective dose equivalent at each field organization which is attributed to each facility type.

Trends in collective dose equivalents from 1974 to 1979 can be observed in Table 8 for each field organization.

BEST DOCUMENT AVAILABLE

TABLE 6. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1979

Field Organization	No. Individuals Monitored	No. Individuals With Measurable Exposure	Collective Dose Equivalent (Person-rem)	Average Dose Equivalent (mrem) Per Individual Monitored	Average Dose Equivalent (mrem) Per Individual Monitored With Measurable Exposures
Albuquerque	30,110	17,250	1,873	62	109
Chicago	20,101	5,078	1,061	53	209
Grand Junction	157	47	8	51	170
Idaho	41,256	2,552	876	21	343
Nevada	19,094	256	31	2	0.121
Oak Ridge	27,584	18,481	1,332	48	72
Pittsburgh Naval Reactor	2,596	2,091	196	76	93
Richland	9,729	8,807	2,571	264	292
San Francisco	30,271	2,593	264	9	102
Schenectady Naval Reactor	2,565	1,596	114	44	71
Savannah River	11,108	5,976	1,343	121	225
TOTAL	194,571	64,727	9,669	50	150

BEST DOCUMENT AVAILABLE

BEST DOCUMENT AVAILABLE

TABLE 7. Fraction of Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors Attributed to a Facility Type Within Each Field Organization, 1979

	Facility Type									
Field Organization	Reactor	Fuel Fab.	Fuel Proc.	Uran. Enrich.	Weapon F&T	Gen. Research	Acceler.	Other	Visitor	DOE Office
Albuquerque					0.524	0.273	0.001	0.191	0.012	
Chicago	0.056				0.307	0.456	0.055	0.126		
Grand Junction								1.00		
Idaho	0.293		0.697							0.010
Nevada					0.774				0.226	
Oak Ridge		0.072		0.350	0.158	0.228		0.173	0.017	0.001
Pittsburgh Naval Reactor	0.311					0.648		0.010	0.020	0.010
Richland	0.296	0.020				0.115		0.541	0.026	0.002
San Francisco					0.004	0.602	0.030	0.326	0.038	
Schenectady Naval Reactor	0.623					0.316		0.009	0.044	0.009
Savannah River	0.134	0.098	0.447		0.023	0.065		0.221	0.010	0.002
ALL FIELD ORGANIZATIONS COMBINED	0.144	0.029	0.125	0.048	0.129	0.191	0.051	0.215	0.064	0.004

BEST DOCUMENT AVAILABLE

TABLE 8. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1974-1979(a)

Field Organization	1974	1975	1976	1977	1978	1979
Albuquerque	2,405	2,324	1,437	2,300	2,399	1,873
Chicago	1,943	1,638	1,354	1,373	1,167	1,061
Grand Junction	0	5	<1	<1	2	8
Idaho	686	611	790	929	899	876
Nevada	58	55	25	49	47	31
Oak Ridge	1,178	1,284	1,351	1,300	1,566	1,332
Pittsburgh Naval Reactor	587	1,876	1,609	653	252	196
Richland	2,079	2,257	2,265	3,197	2,596	2,571
San Francisco	320	283	285	334	307	264
Schenectady Naval Reactor	261	1,022	203	148	111	114
Savannah River	1,434	1,268	1,278	1,298	1,289	1,343
TOTAL	10,951	12,622	10,597	11,581	10,635	9,669

(a) Throughout this report, minor variations in collective dose-equivalent values may occur due to computer rounding.

SUMMARY OF INTERNAL EXPOSURES

Internal body depositions of radioactive material result from accidental, not planned, exposures. A report of internal body deposition of radioactive materials is required when:

1. any uptake of radioactive material occurred during the reporting year that either independently or when added to a current burden was estimated to result in a dose commitment to the critical organ in excess of 50% of the pertinent annual dose equivalent standard set forth in DOE Order 5484.1, Chapter XI; or when

2. any previously unreported uptake of radioactive material was determined to have been reportable according to the above criteria by reason of the most recent dose-equivalent estimates.

Table 9 gives a three-year comparison of new cases of internal body depositions. Only those cases occurring within each year are included. Cases where the effects of prior years' depositions are continuing or where a new uptake is not clearly identified are not included.

TABLE 9. Dose Distributions for Cases of Internal Body Depositions, 1977-1979

Year	Radionuclide	Critical Organ	Dose Equivalent Interval (rem) 7.5-10	10-15	15-25	25-50	50-100	100-200
1977	^{238}Pu	Lung	1		1	1		
1978	^{239}Pu, ^{240}Pu, ^{241}Pu	Lung	1					
	^{125}I	Thyroid	1					
1979	^{234}U, ^{235}U, ^{238}U	Lung	2					

Of 16 reported body deposition cases for 1979, two are considered new and are included in Table 9. The 14 remaining cases are not included for the following reasons: in five cases, the current burden has decreased from the measured level of previous years. These instances are judged as continued tracking of a previous uptake. In eight other cases, the reported current burden was slightly higher than was previously measured, indicating either a re-evaluation of the burden, or a possible new uptake. In one final case, a 1979 dose commitment of 33.75 rem to the bone was noted to be a translocation of a reported 1977 lung deposition.

SUMMARY OF WORKER TERMINATIONS

There were 8,968 monitored workers in 1979 who terminated their employment with DOE or DOE contractors. Table 10 gives the length of employment as well as the average cumulative dose equivalent for the workers in each time interval. These data indicate that the average cumulative dose equivalent for workers terminating in 1979 after 1 to 365 days of employment was significantly less than the 5 rem-per-year radiation protection standard for the whole body.

The average cumulative dose equivalent for workers who terminated after more than six years of employment was 2.39 rem. This average appears high in comparison with the average cumulative dose equivalent for employees who terminated with less than six years of employment. However, this average includes the cumulative exposure of individuals who worked for DOE or DOE contractors for more than 20 years.

TABLE 10. Average Cumulative Dose Equivalent for Individuals Terminating in 1979

Length of Employment	Number of Terminated Employees	Total Cumulative Dose Equivalent (Person-rem)	Average Cumulative Dose Equivalent Per Terminated Employee (rem)
1-90 days	2,229	1,066	0.48
90-180 days	1,003	222	0.22
180-365 days	970	180	0.19
1-2 years	1,240	364	0.29
3-4 years	1,019	404	0.40
5-6 years	490	332	0.68
>6 years	2,017	4,829	2.39

BEST DOCUMENT AVAILABLE

APPENDIX A

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE FOR EACH DOE FIELD ORGANIZATION, 1979

TABLE A.1
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
ALBUQUERQUE FIELD ORGANIZATION
1979

Facility Type	Total Monitored	< Meas.	Dose Equivalent Ranges (rem) Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	7940	847	5802	594	303	136	83	140	26	1	7	1						981
Gen. Research	9685	6753	2111	385	204	102	46	72	4	5	2						1	511
Accelerator																		
Other	46	35	11															1
Visitors	11642	4755	6834	40	9	1		3										357
DOE Offices	797	470	303	15	6	1	1	1										23
TOTAL	30110	12860	15061	1034	522	240	130	216	30	6	9	1					1	1873
TOTAL PERSON-REM			753	181	196	150	114	324	75	21	41	5					13	1873

BEST DOCUMENT AVAILABLE

TABLE A.2
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
CHICAGO FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	314	75	94	79	38	12	9	7										59
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	5259	2976	1697	315	131	67	39	25	8	1								326
Accelerator	3205	1642	843	293	175	73	51	95	24	8	1							484
Other	887	678	144	30	8	6	5	6	10									58
Visitors	10413	9636	508	144	59	40	9	14	3									134
DOE Offices	23	16	7															
TOTAL	20101	15023	3293	861	411	198	113	147	45	9	1							1061
TOTAL PERSON-REM			165	151	154	124	99	221	112	31	4							1061

BEST DOCUMENT AVAILABLE

TABLE A.3
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
GRAND JUNCTION FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research																		
Accelerator																		
Other	148	101	18	20	8	1												8
Visitors	8	8																
DOE Offices	1	1																
TOTAL	157	110	18	20	8	1												8
TOTAL PERSON-REM			1	3	3	1												8

BEST DOCUMENT AVAILABLE

TABLE A.4
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
IDAHO FIELD ORGANIZATION
1979

Facility Type	Total Monitored	< Meas.	Dose Equivalent Ranges (rem) Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	3024	1780	691	257	155	84	33	21	3									256
Fuel Fabrication																		
Fuel Processing	2066	910	421	193	173	98	68	142	58	3								609
Uran. Enrichment																		
Weapon F&T																		
Gen. Research																		
Accelerator																		
Other																		
Visitors	35929	35922	6	1														
DOE Offices	237	92	133	10	1	1												9
TOTAL	41256	38704	1251	461	329	183	101	163	61	3								876
TOTAL PERSON-REM			63	81	123	114	88	245	152	10								876

BEST DOCUMENT AVAILABLE

353

TABLE A.5
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
NEVADA FIELD ORGANIZATION
1979

Facility Type	Total Monitored	< Meas.	Dose Equivalent Ranges (rem) Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	6747	6613	99	20	12	2										1		24
Gen. Research																		
Accelerator																		
Other	197	195	2															
Visitors	11306	11192	105	7	2													7
DOE Offices	844	838	6															
TOTAL	19094	18838	212	27	14	2										1		31
TOTAL PERSON-REM			11	5	5	1										9		31

BEST DOCUMENT AVAILABLE

TABLE A.6
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
OAK RIDGE FIELD ORGANIZATION
1979

Facility Type	Total Monitored	< Meas.	Dose Equivalent Ranges (rem) Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication	600	90	315	85	60	32	8	9	1									96
Fuel Processing																		
Uran. Enrichment	11144	2464	8474	184	18	2	2											466
Weapon F&T	3463		3266	140	48	9												211
Gen. Research	7706	6014	1177	245	117	75	23	46	9									304
Accelerator																		
Other	4059	83	3797	144	26	7	2											231
Visitors	593	448	118	8	6	4	4	5										23
DOE Offices	19	4	15															1
TOTAL	27584	9103	17162	806	275	129	39	60	10									1332
TOTAL PERSON-REM			858	141	103	81	34	90	25									1332

BEST DOCUMENT AVAILABLE

TABLE A.7
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	798	134	530	87	42	5												61
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1487	192	1050	153	65	11	12	4										127
Accelerator																		
Other	44	29	12	1	2													2
Visitors	219	142	77															4
DOE Offices	48	8	38	2														2
TOTAL	2596	505	1707	243	109	16	12	4										196
TOTAL PERSON-REM			85	43	41	10	11	6										196

BEST DOCUMENT AVAILABLE

TABLE A.8
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
RICHLAND FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem) < Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	667	13	85	88	85	46	41	140	157	12								761
Fuel Fabrication	84	1	6	20	17	16	12	9	3									52
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	2205	90	1525	367	109	45	31	36	2									296
Accelerator																		
Other	4913	248	2607	709	481	319	195	300	53	1								1391
Visitors	1807	566	1206	30	5													67
DOE Offices	53	4	42	6	1													4
TOTAL	9729	922	5471	1220	698	426	279	485	215	13								2571
TOTAL PERSON-REM			274	213	262	266	244	728	538	46								2571

BEST DOCUMENT AVAILABLE

TABLE A.9
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SAN FRANCISCO FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	2	2																
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	106	98	6	1	1													1
Gen. Research	13352	11340	1801	127	55	18	5	5	1									159
Accelerator	197	145	35	6	7	3	1											8
Other	1054	680	280	37	18	10	4	15	8	2								86
Visitors	15508	153666	134	6	1			1										10
DOE Offices	52	47	5															
TOTAL	30271	27678	2261	177	82	31	10	21	9	2								264
TOTAL PERSON-REM			113	31	31	19	9	32	22	7								264

BEST DOCUMENT AVAILABLE

TABLE A.10
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SAVANNAH RIVER FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	981	232	331	133	182	85	13	5										180
Fuel Fabrication	411	56	181	47	41	28	20	32	6									131
Fuel Processing	1664	209	600	267	207	138	70	134	39									600
Uran. Enrichment																		
Weapon F&T	153	24	76	26	15	5		4	3									31
Gen. Research	994	438	425	51	32	22	15	10	1									87
Accelerator																		
Other	4791	2387	1787	387	134	46	23	27										297
Visitors	1891	1614	272	5														14
DOE Offices	223	172	51															3
TOTAL	11108	5132	3723	916	611	324	141	212	49									1343
TOTAL PERSON-REM			186	161	229	203	123	318	123									1343

BEST DOCUMENT AVAILABLE

TABLE A.11
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SCHENECTADY NAVAL REACTORS FIELD ORGANIZATION
1979

Facility Type	Total Monitored	Dose Equivalent Ranges (rem)															Total Person-rem
		< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Reactor	1209	391	684	90	32	7	4	1										71
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1023	354	652	15	2													36
Accelerator																		
Other	41	24	16	1														1
Visitors	269	192	73	2	1	1												5
DOE Offices	23	8	15															1
TOTAL	2565	969	1440	108	35	8	4	1										114
TOTAL PERSON-REM			72	19	13	5	4	1										114

BEST DOCUMENT AVAILABLE

APPENDIX B

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR FOR EACH DOE FIELD ORGANIZATION, 1979

TABLE B.1
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Albuquerque Misc.																	
Employees		1739	29	5	1	1											95
Visitors																	
Total		1739	29	5	1	1											95
General Electric Co.																	
Employees	190	110	19	7													11
Visitors	4																
Total	194	110	19	7													11
Inhalation Toxicology																	
Employees	270	76	8	1	2												7
Visitors	236																
Total	506	76	8	1	2												7
Mason & Hanger-Silas																	
Employees	27	347	172	61	21	9	28	10	1	4	1						185
Visitors	678	322															16
Total	705	669	172	61	21	9	28	10	1	4	1						201
Monsanto Research Co.																	
Employees	439	881	73	40	15	2	6										92
Visitors	610	39															2
Total	1049	920	73	40	15	2	6										94

BEST DOCUMENT AVAILABLE

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Rockwell International																	
Employees		2725	301	190	99	71	106	16		3							597
Visitors		6019															301
Total		8744	301	190	99	71	106	16		3							898
Ross Aviation, Inc.																	
Employees	35	11															1
Visitors																	
Total	35	11															1
Sandia Laboratories, NM																	
Employees	1587	733	90	30	15	5	8	1	4	2							115
Visitors	1843	374	23	5	1												25
Total	3430	1107	113	35	16	5	8	1	4	2							140
Sandia Laboratories, CA																	
Employees	796	98	2														5
Visitors	176	2					1										2
Total	972	100	2				1										7
The Bendix Corp.																	
Employees	191																
Visitors	1																
Total	192																

BEST DOCUMENT AVAILABLE

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
The Zia Company																
Employees	1238	144	54	19	1											24
Visitors																
Total	1238	144	54	19	1											24
U. of California/LASL																
Employees	2862	1060	231	154	84	41	64	3	1							1 360
Visitors	1207	78	17	4			2									11
Total	4069	1138	248	158	84	41	66	3	1							1 371
TOTAL ALBUQUERQUE	12390	14758	1019	516	239	129	215	30	6	9	1					1 1849

BEST DOCUMENT AVAILABLE

TABLE B.2
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Ames Laboratory																	
Employees	39	30	9	3	1	1	1	6	1								26
Visitors	150	13	3	1	2												3
Total	189	43	12	4	3	1	1	6	1								29
Argonne National Lab.																	
Employees	2302	439	220	123	67	37	23	2									220
Visitors	5081	72	47	47	29	6	5										60
Total	7383	511	267	170	96	43	28	2									281
Brookhaven National Lab.																	
Employees	191	1201	287	138	53	38	75	19	8	1							421
Visitors	92	233	68	9	7	2	7	2									49
Total	283	1434	355	147	60	40	82	21	8	1							469
Chicago Miscellaneous																	
Employees	394	224	52	11	4	3	7	10									65
Visitors	388	19	5														2
Total	782	243	57	11	4	3	7	10									67
Fermi National Accel.																	
Employees	1320	375	121	61	26	23	19	5									140
Visitors	2005	168	21	2	2	1	2	1									20
Total	3325	543	142	63	28	24	21	6									161

BEST DOCUMENT AVAILABLE

TABLE B.2 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Massachusetts Inst.																	
Employees	154	149	18	16	7	2	8										35
Visitors	1916	3															
Total	2070	152	18	16	7	2	8										35
Princeton University																	
Employees	892	348	3														18
Visitors																	
Total	892	348	3														18
TOTAL CHICAGO	14924	3274	854	411	198	113	147	45	9	1							1059

BEST DOCUMENT AVAILABLE

TABLE B.3
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
GRAND JUNCTION FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Person-rem
Bendix Field Eng.																	
Employees	101	18	20	8	1												8
Visitors	2																
Total	103	18	20	8	1												8
TOTAL GRAND JUNCTION	103	18	20	8	1												8

BEST DOCUMENT AVAILABLE

TABLE B.4
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Allied Chemical Corp.																
Employees	499	117	65	64	44	26	73	42	3							316
Visitors	5412															
Total	5911	117	65	64	44	26	73	42	3							316
Arrington Const.																
Employees	1	10	2		1											1
Visitors																
Total	1	10	2		1											1
Biggers Const.																
Employees		5			1											1
Visitors																
Total		5			1											1
Bingham Mechanical																
Employees	3	11	6	3	2		1									5
Visitors																
Total	3	11	6	3	2		1									5
C-L Electric Company																
Employees		2		1												
Visitors																
Total		2		1												

BEST DOCUMENT AVAILABLE

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
EG&G, Idaho, Inc.																	
Employees	1316	523	181	105	55	25	10										168
Visitors	26942		1														
Total	28258	523	182	105	55	25	10										169
Exxon Nuclear Co.																	
Employees	588	116	79	74	38	30	55	9									202
Visitors	3111	6															
Total	3699	122	79	74	38	30	55	9									203
Idaho Miscellaneous																	
Employees	203	156	63	51	26	8	11	3									85
Visitors																	
Total	203	156	63	51	26	8	11	3									85
Jones-Boecon																	
Employees	6	23		1	1	1											3
Visitors																	
Total	6	23		1	1	1											3
Lehigh Design Co.																	
Employees	27	7															
Visitors																	
Total	27	7															

BEST DOCUMENT AVAILABLE

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Morrison-Knudsen																	
Employees	46	116	46	29	13	11	13	7									79
Visitors																	
Total	46	116	46	29	13	11	13	7									79
Ormond Construction																	
Employees	1	24	8		1												3
Visitors																	
Total	1	24	8		1												3
Waters Asbestos																	
Employees		2															
Visitors																	
Total		2															
TOTAL IDAHO	38155	1118	451	328	182	101	163	61	3								867

BEST DOCUMENT AVAILABLE

TABLE B.5
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Air Resources Lab.																	
Employees	48																
Visitors	6																
Total	54																
CER Geonuclear																	
Employees	3																
Visitors																	
Total	3																
Defense Nuclear Agency																	
Employees	192	2															2
Visitors	2998	32	1														2
Total	3190	34	1														
EG&G, Inc.																	
Employees	865	35	1		1												3
Visitors	98																
Total	963	35	1		1												3
EPA/NERC																	
Employees	225	2															
Visitors	54																
Total	279	2															

BEST DOCUMENT AVAILABLE

TABLE B.5 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Fenix & Scisson, Inc.																	
Employees	215	10		2													1
Visitors	273																
Total	488	10		2													1
Holmes & Narver, Inc.																	
Employees	285	5															
Visitors	122																
Total	407	5															
Nevada Miscellaneous																	
Employees	249	2															
Visitors	244	1															
Total	493	3															
Reynolds Electrical																	
Employees	4192	36	19	10	1										1		19
Visitors	3256																
Total	7448	36	19	10	1										1		19
U.S. Dept. of Interior																	
Employees	149	5															
Visitors	20																
Total	169	5															

BEST DOCUMENT AVAILABLE

TABLE B.5 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Person-rem
Wackenhut Services																	
Employees	244	4															
Visitors	67																
Total	311	4															
Westinghouse Electric																	
Employees	141																
Visitors	91																
Total	232																
TOTAL NEVADA	14037	134	21	12	2										1		26

BEST DOCUMENT AVAILABLE

TABLE B.6
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-Rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Comp. Animal Res. Lab.																
Employees	107	19														1
Visitors	12															
Total	119	19														1
Goodyear Atomic Corp.																
Employees	735	180	57	12	2											25
Visitors																
Total	735	180	57	12	2											25
National Lead Co.																
Employees	90	314	85	60	32	8	9	1								96
Visitors																
Total	90	314	85	60	32	8	9	1								96
Oak Ridge Assoc. Univ.																
Employees	412	153	12	2												11
Visitors																
Total	412	153	12	2												11
Puerto Rico Nuclear Ctr.																
Employees	123	49	25	1	2											8
Visitors	379	87														4
Total	502	136	25	1	2											12

BEST DOCUMENT AVAILABLE

TABLE B.6 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
RMI Company																	
Employees	14	45	19	2													6
Visitors																	
Total	14	45	19	2													6
Rust Engineering Co.																	
Employees		1374	97	1													86
Visitors																	
Total		1374	97	1													86
Union Carbide Corp./ORGDP																	
Employees		7578	88	4		2											398
Visitors																	
Total		7578	88	4		2											398
Union Carbide Corp./Y-12																	
Employees		6132	173	53	14	1											366
Visitors																	
Total		6132	173	53	14	1											366
Union Carbide Corp./ORNL																	
Employees	5441	468	202	112	68	22	46	9									254
Visitors	57	31	8	6	4	4	5										19
Total	5498	499	210	118	72	26	51	9									273

BEST DOCUMENT AVAILABLE

TABLE B.6 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Union Carbide Corp.																	
Employees	1729	716	39	2													43
Visitors																	
Total	1729	716	39	2													43
Woven Structures, Inc.																	
Employees			1	20	7	2											14
Visitors																	
Total			1	20	7	2											14
TOTAL OAK RIDGE	9099	17146	806	275	129	39	60	10									1331

BEST DOCUMENT AVAILABLE

TABLE B.7
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Duquesne Light Co.																	
Employees	1	204	72	37	5												40
Visitors	14	40															2
Total	15	244	72	37	5												42
Westinghouse Electric/BAPL																	
Employees	180	863	71	27	4	11	4										84
Visitors	76	20															1
Total	256	883	71	27	4	11	4										85
Westinghouse Electric/NRF																	
Employees	145	513	97	43	7	1											64
Visitors	52	17															1
Total	197	530	97	43	7	1											65
Westinghouse Plant Appa.																	
Employees	29	12	1	2													2
Visitors																	
Total	29	12	1	2													2
TOTAL PITTSBURGH	497	1669	241	109	16	12	4										193

BEST DOCUMENT AVAILABLE

TABLE B.8
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Automation Industries																	
Employees	28	218	16	1	1												15
Visitors	2	2															
Total	30	220	16	1	1												15
Pacific Northwest Laboratory																	
Employees	40	783	147	54	14	5	10	2									118
Visitors	40	53															3
Total	80	836	147	54	14	5	10	2									121
BCS Richland Inc.																	
Employees	4	4	1														
Visitors	1	2															
Total	5	6	1														
Hanford Eng. Dev. Lab.																	
Employees	50	742	220	55	31	26	26										177
Visitors	32	40	5														3
Total	82	782	225	55	31	26	26										180
Hanford Environ. Health Found.																	
Employees		4															
Visitors		1															
Total		5															

BEST DOCUMENT AVAILABLE

TABLE B.8 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
J.A. Jones Const. Co.																	
Employees	145	814	197	210	204	129	189	26	1								746
Visitors		3															
Total	145	817	197	210	204	129	189	26	1								746
Rockwell Hanford Oper.																	
Employees	71	1567	495	270	114	66	111	27									629
Visitors	435	958	21	3													53
Total	506	2525	516	273	114	66	111	27									682
United Nuclear Ind. Inc.																	
Employees	14	91	108	102	62	53	149	160	12								812
Visitors	3	47	4	2													4
Total	17	138	112	104	62	53	149	160	12								816
TOTAL RICHLAND	865	5329	1214	697	426	279	485	215	13								2561

BEST DOCUMENT AVAILABLE

TABLE B.9
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Rockwell International Energy Systems Group																
Employees	680	280	37	18	10	4	15	8	2							86
Visitors	545	67	2	1												4
Total	1225	347	39	19	10	4	15	8	2							91
Stanford Linear Accel. Ctr.																
Employees	145	35	6	6	1											6
Visitors																
Total	145	35	6	6	1											6
U. of California/LBL																
Employees	3557	1065	72	19	7		1									79
Visitors																
Total	3557	1065	72	19	7		1									79
U. of California/LLL																
Employees	7473	708	52	32	10	5	4	1								76
Visitors	14821	67	4				1									6
Total	22294	775	56	32	10	5	5	1								81
U. of California/LEHR																
Employees	162	14	1	2												2
Visitors																
Total	162	14	1	2												2

BEST DOCUMENT AVAILABLE

TABLE B.9 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
U. of California/LNM																
Employees	122	14	2	3	3	1										5
Visitors																
Total	122	14	2	3	3	1										5
U. of California/MC																
Employees	26															
Visitors																
Total	26															
U. of California/NTS																
Employees	100	6	1	1												1
Visitors																
Total	100	6	1	1												1
TOTAL SAN FRANCISCO	27631	2256	177	82	31	10	21	9	2							264

BEST DOCUMENT AVAILABLE

TABLE B.10
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAVANNAH RIVER FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
E.I. du Pont/SRP-Opns.																	
Employees	2212	2324	622	501	283	123	193	49									1109
Visitors	1614	272	5														14
Total	3826	2596	627	501	283	123	193	49									1124
E.I. du Pont/SRP-Const.																	
Employees	1060	1046	289	110	41	18	19										214
Visitors																	
Total	1040	1046	289	110	41	18	19										214
Savannah River Ecol. Lab.																	
Employees	38	28															1
Visitors																	
Total	38	28															1
Southern Bell Tel.																	
Employees	36	2															
Visitors																	
Total	36	2															
TOTAL SAVANNAH RIVER	4960	3672	916	611	324	141	212	49									1339

BEST DOCUMENT AVAILABLE

TABLE B.11
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SCHENECTADY NAVAL REACTORS FIELD ORGANIZATION
1979

Contractor	Dose Equivalent Ranges (rem)															Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
General Electric Co.																
Employees	745	1336	105	34	7	4	1									107
Visitors	192	73	2	1	1											5
Total	937	1409	107	35	8	4	1									112
General Electric/MAO																
Employees	24	16	1													1
Visitors																
Total	24	16	1													1
TOTAL SCHENECTADY	961	1425	108	35	8	4	1									113
TOTAL DOE CONTRACTORS	123622	50799	5827	3084	1556	828	1308	419	33	10	1				1	1	9610

BEST DOCUMENT AVAILABLE

APPENDIX C

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION, 1979

TABLE C.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1979

Organization	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Albuquerque Operations	196	120	2	1													7
Amarillo Area Office	1	22	11			1											4
Dayton Area Office	5	17															1
Kansas City Area Office	9																
Los Alamos Area Office	252	79		3			1										7
Pinellas Area Office	6	2															
Rocky Flats Area Office		61	2	2	1												5
Sandia Area Office	1	2															
TOTAL	470	303	15	6	1	1	1										23
Chicago Operations	16	7															
Environmental Meas. Lab.	28	3	4														1
New Brunswick Lab.	55	9	3														1
TOTAL	99	19	7														2

BEST DOCUMENT AVAILABLE

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1979

Organization	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Grand Junction	7																
TOTAL	7																
Idaho Operations	549	133	10	1	1												9
TOTAL	549	133	10	1	1												9
Nevada Operations	4801	78	6	2													6
TOTAL	4801	78	6	2													6
Oak Ridge Operations	3	16															1
Paducah Area Office	1																
TOTAL	4	16															1
Pittsburgh Naval Reactors	8	38	2														2
TOTAL	8	38	2														2

BEST DOCUMENT AVAILABLE

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1979

Organization	Dose Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Richland Operations	57	142	6	1													9
TOTAL	57	142	6	1													9
San Francisco Operations	47	5															
TOTAL	47	5															
Schenectady Naval Reactor	8	12															1
West Milton Field Office		3															
TOTAL	8	15															1
Savannah River Operations	172	51															3
TOTAL	172	51															3
TOTAL DOE GOVERNMENT	6222	800	46	10	2	1	1										56

☆U.S. GOVERNMENT PRINTING OFFICE: 1982-361-078/3071

BEST DOCUMENT AVAILABLE